Department of Fisheries and Oceans
Canadian Stock Assessment Secretariat
Research Document 98/79

Not to be cited without
permission of the authors[1]

Ministère des pêches et des océans
Secrétariat canadien pour l'évaluation des stocks
Document de recherche 98/79

Ne pas citer sans
autorisation des auteurs[1]

SCALLOP PRODUCTION AREA 3: 1997 STOCK ASSESSMENT (BRIER ISLAND AND LURCHER SHOAL)

E. Kenchington and M.J. Lundy

Invertebrate Fisheries Division
Bedford Institute of Oceanography
Department of Fisheries and Oceans
P.O. Box 1006, Dartmouth, N.S.
B2Y 4A2

[1] This series documents the scientific basis for the evaluation of fisheries resources in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

[1] La présente série documente les bases scientifiques des évaluations des ressources halieutiques du Canada. Elle traite des problèmes courants selon les échéanciers dictés. Les documents qu'elle contient ne doivent pas être considérés comme des énoncés définitifs sur les sujets traités, mais plutôt comme des rapports d'étape sur les études en cours.

Les documents de recherche sont publiés dans la langue officielle utilisée dans le manuscrit envoyé au secrétariat.

104-06340/

Abstract

This document presents the results and analysis of the 1997 scallop stock survey in Scallop Production Area 3 off Yarmouth, Nova Scotia. Survey biomass and abundance is calculated and used to evaluate stock status, exploitation levels, stock outlook and the impact of the management restrictions.

The 1997 survey identified a strong 1995 year class distributed in the shallow water areas over most of the grounds. This year class will recruit to the gear in 1998, but yield per recruit analysis (Kenchington *et al.* 1997) recommends fishing the scallops at age 7. This year class will be vulnerable to growth overfishing on the present blended meat count of 45/500 g. A straight count of 45/500 g would protect this year class. The survey total fishable biomass (Age 5+) in Area 3 is approximately 414 mt. The survey total number of animals available to the fishery (Age 5+) is approximately 41 million. Extrapolations to population biomass were made but are thought to be unreliable due to poor estimates of q.

Exploitation rate on the 4+/5+ age groups on both beds decreased dramatically to approximately 20% from 45% in the previous year, while exploitation of the 5+/6+ animals was similar to 1996 on the Brier Island beds, but fell sharply on the Lurcher grounds. CPUE was the lowest on record for this area and effort in terms of the number of hours fished increased over the 1996 level. 71% of the 99 Full Bay vessels licenced to fish in this area did so in 1997.

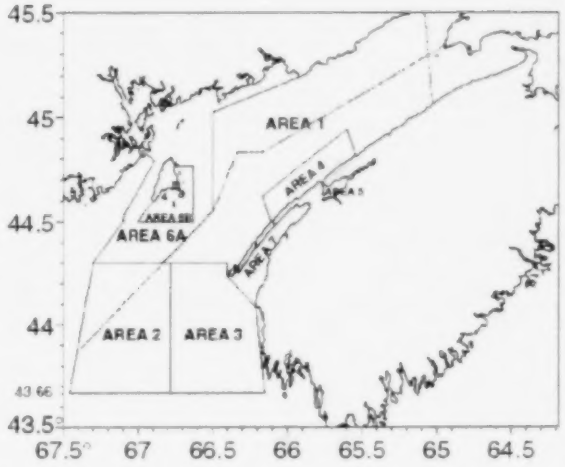
Résumé

On trouvera dans le présent document les résultats et l'analyse du relevé de 1997 du stock de pétoncle de la zone 3 de pêche du pétoncle, située au large de Yarmouth, en Nouvelle-Écosse. La biomasse et l'abondance ont été calculées et appliquées à l'évaluation de l'état du stock, des niveaux d'exploitation, du devenir du stock et des incidences des restrictions imposées par la gestion.

Le relevé de 1997 a permis de déceler une forte classe d'âge pour 1995 dont les individus étaient répartis dans les zones peu profondes de la plupart des fonds. Cette classe sera recrutée par la pêche en 1998, mais l'analyse du rendement par recrue (Kenchington et coll., 1997) indique que la pêche devrait être faite à l'âge 7. Cette classe sera vulnérable à la surpêche de croissance si l'on applique le compte de chairs mixtes actuel de 45 par 500 g. Un compte de chairs non combinées de 45 par 500 g protégerait cette classe d'âge. La biomasse récoltable totale du relevé (âge 5+) s'élève à 414 t environ dans la zone 3. Le nombre total d'animaux correspondant est de 41 millions environ. Des extrapolations de la biomasse de la population ont été faites, mais elles sont jugées peu fiables étant donné les mauvaises estimations de q.

Le taux d'exploitation des groupes d'âge 4+/5+ sur les deux lits a diminué de façon extrêmement importante pour tomber à 20 %, par rapport à 45 % l'année précédente. Le taux d'exploitation des 5+/6+ a été semblable à celui de 1996 sur les lits de l'île Brier, mais a chuté de façon abrupte sur les lits Lurcher. Le PUE a été le plus faible jamais noté pour cette zone et l'effort, en nombre d'heures de pêche, a augmenté par rapport à 1996. Des 99 bateaux de Full Bay détenant un permis pour la pêche dans cette zone, 71 % ont pratiqué la pêche en 1997.

Scallop Production Area 3: Brier Island and Lurcher Shoal



On January 1,1997 an area based management plan was implemented for the Bay of Fundy. The bay is divided into 7 Scallop Production Areas (SPAs), largely based on the distribution of beds and the biology of the animals (Kenchington *et al.* 1997). Each area is managed by a TAC, corresponding minimum shell height, and a meat count. Previously, the fishery was operated under a competitive strategy.

Scallop Production Area 3 (Brier Island/Lurcher Shoal) is defined by the area inside a line joining the following points: 4418 N 6647 W to 4418 N 6624 W to 4414.2 N 6624 W, to 4405.2 N 6612.5 W then following the coast south to latitude 4340 N then to 4340 N 6647 W to place of origin. The scallops are distributed over the entire Area with the exception of the northwest corner, although rocky bottom near shore deters fishing activity. In 1997 a TAC of 237 mt was set by industry and management. The fishing season was from June 1 to November 10, 1997. The meat count was 45/500g and the minimum shell height was 95 mm. Total landings were reported through dockside monitoring as 190.04 mt as of March 11, 1998.

Area 3 Landings (metric tons meats)

Year	85-89 AVE	1990	1991	1992	1993	1994	1995	1996	1997
Total	16	0	451	827	991	1382	767	200	190

This document presents the results of the 1997 stock survey of Area 3 for the purpose of evaluating the state of the resource and the fishery towards development of the 1998 Bay of Fundy fishing plan.

Research Vessel Stock Surveys

As in previous years (1991-1996), the 1997 stock survey was conducted during the last two weeks of August (August 13 to 27), using the research vessel "J.L. Hart" with 4 gang gear. The gear configuration was unchanged from previous years (see Kenchington *et al.* 1997 for a description of the gear). Small scallops can avoid the drag path or if caught, escape through the steel rings (Robert and Lundy 1989). To estimate the relative abundance of small scallops (< 80

mm shell height) two drags were lined with 38 mm polypropylene stretch mesh. For analysis purposes the average number of scallops caught in unlined gear (> 80 mm) and the average number of scallops caught in lined gear (< 80 mm) were used and then prorated to conventional 7 gang gear to allow for annual comparisons. However the abundance of scallops with shell height under 40 mm (approximately 2 years of age) is not reliably estimated and can only be used as a qualitative index of recruitment.

All tows were 8 minutes in length. To eliminate the effects of tide and vessel speed on the area covered by the gear, the distance towed was determined from continuous recordings of location via a computer linked to a DGPS receiver. The prorated data were then standardized to a tow length of 800 meters (dragged area of 4256 sq. m).

The 1997 survey was of a random design. 120 stations were randomly assigned within Area 3, excluding the inshore portion of the grounds east of longitude 66°15'. Previous surveys assigned stations following a grid pattern and the area surveyed changed from year to year (Fig. 1; the area covered in the 1997 survey is the largest area covered in the series). From 1991 to 1993 the survey was discontinuous between the two grounds (Fig. 1). From 1995 to 1996 the survey area was continuous between Brier Island and Lurcher Shoal and a subarea allocation was defined as above 44°N for Brier Island, and above 43°40'N and below 44°00'N for Lurcher (Fig. 1). The location of the 1997 tows are shown in figures 1 and 3. At each station the shell height (mm) and meat weight (0.0 g) of each animal captured were recorded. The shell height data was then converted to numbers of animals captured in 5 mm shell height increments.

The average number of scallops-at-age caught in the 1991-1997 stock surveys are given below. The 1997 catch-at-age was determined using the six area and depth defined 1997 growth curves determined from the 1996 survey (Kenchington *et al.* 1997):

Area 3 Subareas by Depth Strata	N	L_{inf} (s.e.)	k (s.e.)	$t_{(0)}$ (s.e.)	r^2
Brier Island < 50m	185	153.678 (4.587)	0.19404 (0.01426)	0.1930 (0.1041)	0.93
Brier Island 51-100m	680	135.924 (0.975)	0.26030 (0.00656)	0.3105 (0.0479)	0.94
Brier Island > 100m	430	129.655 (1.069)	0.25662 (0.01015)	0.1309 (0.1153)	0.87
Lurcher <100m	1536	138.806 (0.969)	0.21068 (0.00524)	-0.3040 (0.0639)	0.93
Lurcher 101-150m	2349	120.654 (0.457)	0.31576 (0.00622)	0.2328 (0.0509)	0.88
Lurcher > 150m	295	119.229 (0.952)	0.28774 (0.01242)	-0.0789 (0.1241)	0.92

The prorated numbers of animals in 5 mm shell height increments were summed and averaged across increments of similar ages by area and depth. The shell height used to calculate age was the shell height at the beginning of the interval plus 2.5 mm.

Scallop Numbers and Spatial Distribution

The spatial distribution of scallop density is highly patchy, however the survey design provides a good estimate of the mean numbers per standard tow as indicated by the standard errors.

1997 Survey Mean Numbers-at-Age per Standard Tow ± Standard Error

Location	4+	5+	6+	Total
	mean ± st. err.	mean ± st. err.	mean ± st. err.	mean ± st. err.
Brier Island	51 ± 15.5	37 ± 6.4	27 ± 3.1	107 ± 22.9
Lurcher Shoal	103 ± 27.3	68 ± 14.8	47 ± 9.2	162 ± 35.3

The total average number of scallops per standard tow caught during the survey has declined dramatically since 1992 and 1993 and remains low in 1997 after a sharp decline in 1995. However, there has been an increase in the average number of scallops per tow (total) in 1997 over 1996 due to the presence of prerecruit scallops (< 4 yrs) on both grounds. On both beds, the dominant age class is the 2 year old scallops. This 1995 year class is much stronger than the 1993 and 1994 year classes, but remains below average in the time series whether all data are included, or whether the highest and lowest values are removed (for each subarea). However, the mean data are not really comparable due to differences in the number of stations sampled and the area sampled over this time series. The 1995 year class may be higher than average, when only the 1995 to 1997 series is considered (surveys of similar tow numbers and area). The older animals have been fished down but are still present on both beds in moderate numbers. The average tow captures more animals on the Lurcher grounds below 44°N than on the Brier Island grounds for all age combinations except the age 2 animals.

Survey Mean Numbers-at-Age per Standard Tow for Brier Island (north of 44° latitude)
Calculated with 1997 Growth Curves. Surveys after 1994 are of Comparable Area and Design

	Age													
Year	2	3	4	5	6	7	8	9	10+	4+	5+	6+	Total	No. Stations
1991	32	7	11	11	5	7	4	2	22	62	51	40	101	28
1992	598	26	22	18	9	11	7	4	26	97	75	57	718	23
1993	101	181	122	58	22	10	7	4	24	247	125	67	529	32
1994	63	39	140	49	14	9	7	4	19	242	102	53	344	35
1995	11	4	7	14	9	5	4	3	14	56	49	35	71	42
1996	7	5	7	7	10	8	4	2	10	48	41	34	60	45
1997	48	6	14	10	4	8	2	6	7	51	37	27	107	47

Survey Mean Numbers-at-Age per Standard Tow for Lurcher Shoal (south of 44° latitude) Calculated with 1997 Growth Curves. Surveys after 1994 are of Comparable Area and Design

	Age													
Year	2	3	4	5	6	7	8	9	10+	4+	5+	6+	Total	No. Stations
1991	64	10	21	43	15	4	2	1	10	96	75	32	170	31
1992	126	66	57	49	26	10	6	5	15	168	111	62	360	24
1993	479	194	141	88	36	20	16	11	24	336	195	107	1009	49
1994	51	67	112	63	30	14	10	6	16	251	139	76	369	61
1995	23	15	32	41	25	12	10	7	17	144	112	71	182	60
1996	3	26	24	23	17	10	8	5	10	97	73	50	126	68
1997	39	20	35	21	21	9	6	3	8	103	68	47	162	73

A survey abundance index was calculated for the Brier and Lurcher subareas of Area 3 by determining the number of animals per standard tow above age 3 (recruited scallops) and below age 4 (prerecruit scallops). These are illustrated in figure 2. It can readily be seen that there has been an increase in the number of prerecruits from 1996 to 1997 especially in the Brier Island subarea.

The spatial distributions of scallops, determined from the biomass surveys, have been presented using a contouring approach since 1990 (Robert *et al.* 1990). The spatial distribution of the scallops is contoured using the ACON software package (Black 1988) with data derived from Delaunay triangles and inverse distance weighted interpolation (Watson and Phillip 1985) as detailed in Robert *et al.* (1990). The spatial distributions of scallops in Area 3 were mapped according to size. Animals greater than or equal to 80 mm shell height (recruits), animals less than 80 mm shell height (prerecruits), and the total number of animals per standard tow are shown in figures 3 to 5 respectively.

The largest concentrations of scallops (>500 per standard tow) are in the deeper water off Lurcher Shoal (Fig. 3). The pre-recruit scallops are found in shallower water at concentrations of >250 animals per standard tow (Fig. 4). They occur in patches throughout the area with the exception of the deep water in the northwest and southwest portions of Area 3. The shallow water above 44°N is a good growth area and the yield from these pre-recruits will be important for the revitalization of this area. The total distribution of animals (Fig. 5) indicates that the greater portion of the area has average catches of 1 to 100 animals per standard tow.

The incidence of "clappers" (paired empty shells) on both beds increased in the surveys from lows of less than 2.5% from 1991 to 1993, to 16% in 1994. Most of the clappers in 1994, 1995, and 1996 are on the Lurcher bed. In 1997, the percentage of clappers fell on both beds and is similar between them.

Percent Clappers (Paired Empty Shells) in Survey Catch

	1991	1992	1993	1994	1995	1996	1997
Brier Island	0.9	1.4	2.0	5.4	8.1	7.3	4.8
Lurcher	1.3	1.6	2.3	20.5	16.8	11.1	5.4

The size frequency distribution of the standardized (prorated) total number of live animals and clappers caught during the survey is illustrated in figure 6. The clappers are concentrated in the recruited size classes (>80 mm shell height) but are spread throughout that distribution on both beds. Figures 7 and 8 show the change in the size frequency distribution of the survey catch from 1996 to 1997 for the Brier Island and Lurcher subareas respectively. In both figures the increase in the number of small scallops is readily seen.

The catch per unit effort (± std. dev.) of the research vessel was 4.83±6.08 kg/hr on Brier Island, 6.61±9.91 kg/hr on Lurcher Shoal and 5.86±8.63 kg/hr over the whole area. This calculation was based on the weight of the total number of animals > 80 mm caught in the unlined buckets prorated to 7 gangs and 8 minute tows. The 1997 average research vessel CPUE values were identical to within 0.1 kg to the 1996 values.

The similarity of survey areas in 1995 through 1997 allowed the calculation of Fishing Mortality estimates (F) on each of the beds (see below). 1994 survey data were included to supplement the series, although there was some difference in area surveyed (1994 area subsumed in the 1995+ areas). The estimates were based on the exploited age groups, ages 4+ to 6+, and assuming a Natural Mortality (M) of 0.1 (Merrill and Posgay 1964).

The exploitation of the Brier Island beds was significantly lower from 1995 to 1996 than from 1994 to 1995 in both age groups, while exploitation of the Lurcher Shoal beds was slightly lower from 1995 to 1996 in the age 4+/5+ calculations and slightly higher in the age 5+/6+ calculations than in the previous year. The 1996 to 1997 data show a decrease in exploitation rate on the 4+/5+ age groups on both beds, while exploitation of the 5+/6+ animals was similar to 1995 to 1996 on the Brier Island beds, but fell sharply on the Lurcher grounds in 1996 to 1997. The bulk of the fishing occurs before the survey in August and so 1996 to 1997 comparisons reflect effort in the 1997 fishery.

Mortality and Exploitation Levels for Area 3: Brier Island and Lurcher Shoal

Age 4+/5+			
Subarea	Total Mortality (Z)	Fishing Mortality (F)	Exploitation
Brier Island			
1994-1995	1.60	1.50	74.8%
1995-1996	0.31	0.21	18.1%
1996-1997	0.21	0.11	9.9%
Lurcher			
1994-1995	0.81	0.71	48.7%
1995-1996	0.68	0.58	42.1%
1996-1997	0.36	0.26	21.8%

Mortality and Exploitation Levels for Area 3: Brier Island and Lurcher Shoal *cont'd*

Age 5+/6+			
Subarea	Total Mortality (Z)	Fishing Mortality (F)	Exploitation
Brier Island			
1994-1995	1.07	0.97	59.6%
1995-1996	0.37	0.27	22.6%
1996-1997	0.35	0.25	21.1%
Lurcher			
1994-1995	0.67	0.57	41.5%
1995-1996	0.81	0.71	48.7%
1996-1997	0.46	0.36	28.9%

Survey Abundance and Biomass Estimates

Biomass-at-age estimates were calculated with the 1996 mean weights-at-age calculated separately for the two subareas:

Brier Island										
Age (yr)	1	2	3	4	5	6	7	8	9	10
Wt. (g)	0.11	0.97	2.8	5.72	8.17	10.19	11.99	13.58	14.73	19.09
Lurcher										
Age (yr)	1	2	3	4	5	6	7	8	9	10
Wt. (g)	0.18	1.06	2.89	4.65	6.63	8.34	9.54	10.62	11.86	15.52

The mean number of animals per standard tow (given on pages 3 and 4) was multiplied by 10^6 and divided by 4256 (the dragged area in square meters of a standard tow) to produce the average number of animals by age per km^2. The total area of the Brier Island portion of Area 3 was estimated as 1314.482246 km^2 and the total area of the Lurcher portion of Area 3 was estimated as 1839.047528 km^2. The average number of animals by age/km^2 was multiplied by these numbers to produce the total number of scallops in the Area. This number was then multiplied by the average biomass-at-age above to produce the survey total biomass-at-age. The survey total fishable biomass (Age 5+) in Area 3 is approximately 414 mt. The survey total number of animals available to the fishery (Age 5+) is approximately 41 million (40,810,873).

Population Abundance and Biomass Estimates

The abundance and biomass figures calculated from the survey data underestimate the population abundance and biomass by the catchability of the survey (q). Kenchington *et al.* (1997) report the average 1/q for age groups 4+, 5+ and 6+ as 0.87, 1.14 and 1.94 , respectively. However they concluded that the estimates of q do not appear to be reliable with our present set of data. These values give population estimates of 4+ as 52,424,959, 5+ as 46,524,395 and 6+ as 55,577,289 animals. The corresponding population biomasses are 581 mt (4+), 555 mt (5+), and 708 mt (6+). Obviously, it does not make sense to have more animals in the 6+ group than in the 4+ group.

Survey Abundance and Biomass by Age

	Brier Island			Lurcher		
Age	Mean No./Std. Tow	Total Number	Total Biomass (kg)	Mean No./Std. Tow	Total Number	Total Biomass (kg)
2	48	14,824,988	14,380	39	16,852,174	17,863
3	6	1,853,123	5,189	20	8,642,141	24,976
4	14	4,323,955	24,733	35	15,123,746	70,325
5	10	3,088,539	25,233	21	9,074,248	60,162
6	4	1,235,416	12,589	21	9,074,248	75,679
7	8	2,470,831	29,625	9	3,888,963	37,101
8	2	617,708	8,388	6	2,592,642	27,534
9	6	1,853,123	27,297	3	1,296,321	15,374
10	7	2,161,977	41,272	8	3,456,856	53,650
4+	51	15,751,549	169,138	103	44,507,024	339,826
5+	37	11,427,595	144,405	68	29,383,278	269,501
6+	27	8,339,056	106,582	47	20,309,031	209,339
Total	107	32,429,661	188,707	162	70,001,339	382,665

1997 Fishing Activity

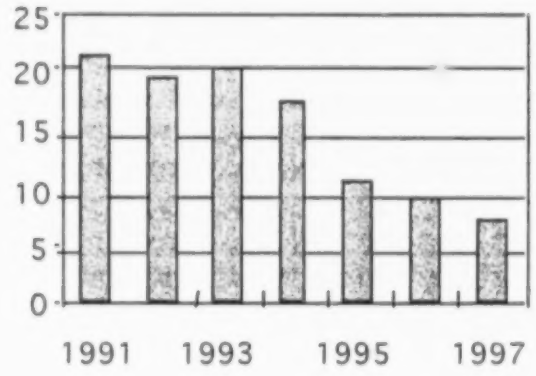
The 1997 logbooks were screened for Class 1 (complete) data so that catch per unit effort (CPUE) could be calculated. Logbook compliance has been poor (13%) in the recent past (1990) but was at 97% in 1994, 77% in 1995, and 100% in 1996 and 1997 under the dockside monitoring scheme. The 1997 CPUE in Area 3 was 7.10 kg/h based upon a Class 1 catch of 157.4 mt or 83% of the total catch. Data were obtained from 70 vessels, a decrease of 29% from 1996. Fishing locations during the 1997 fishery in Area 3 are illustrated in figure 9.

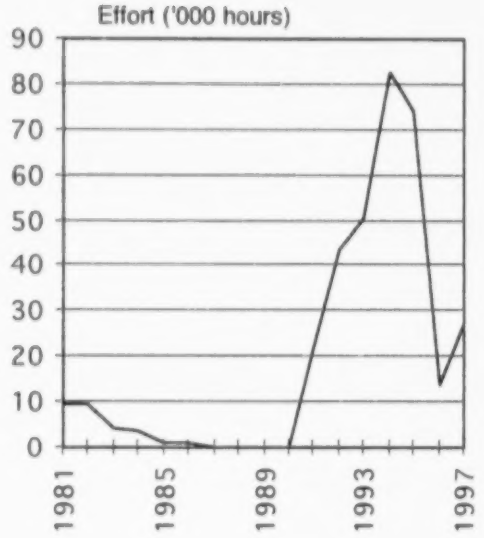
Catch per unit effort was the lowest on record for this Area in 1997, falling below the low level reported in 1996. The summary statistics for CPUE from 1991 to 1997 are shown below (Area 3 CPUE 1991-1995 recalculated from Kenchington and Lundy 1996):

CPUE kg/h

Year	Brier Island	Lurcher Shoal	Combined Area 3
1991	17.7	30.2	21.6
1992	20.0	18.9	19.4
1993	17.2	23.0	20.1
1994	17.0	16.9	17.0
1995	10.6	10.4	10.4
1996	-	-	9.2
1997	-	-	7.1

Area 3: CPUE kg/hour





Effort, in terms of number of hours fished increased in 1997 to 26,765 hours from 13,792 hours in 1996. The peak in effort occurred in 1993 when 827,837 hours were fished.

The commercial CPUE statistics for the whole area are higher than those from the research vessel survey (5.86 kg/h), probably due to commercial targeting of high catch areas as opposed to the survey of the whole area.

Port Sampling of Commercial Catch

Port sampling of the commercial catch has been carried out from Digby, and Yarmouth, N.S. The total number of port samples from throughout the Bay has increased dramatically since 1995 and there has been an improvement in the number of samples coming from a small number of vessels:

Year	No. Samples	No. Vessels	% from 2 vessels	% from 3 vessels	% from 4 vessels
1995	104	9	58.7	77.9	85.6
1996	206	27	27.7	34.9	41.7
1997	339	50	16.2	22.7	28.6

When a vessel lands, two samples of approximately 500 grams each are removed from the catch, and date, vessel, location and depth fished are recorded. The catch muscle is then removed from the adductor muscle and each adductor muscle is weighed and recorded for each of the two samples. This separation of the muscles is done because the catch muscle is not always attached

to the adductor, as a result of processing.

The mean, standard deviation and range of meat weights are calculated on a monthly basis when data is available. A "meat count" of the sample is then calculated by dividing 500 (g) by the mean meat weight (g). The meat count regulation for this area was 45 meats per 500 g in 1997. The mean meat weight (g) per month and associated statistics are given below. These data do not include the weight of the catch muscle, however, this has been calculated as 5-7% of the total (e.g. 4 g meat could have been landed as a 4.28 g meat with catch on). Also, fishermen do not remove the entire muscle when "shucking" the meat. A portion of the muscle is commonly left on each valve. The percent of the meat discarded has not been calculated for Digby shuckers, and is expected to vary with shell shape in the different parts of the Bay, and with catch abundance. Due to this Area being closed for a large portion of the year (see above) samples could only be expected from June through to November. The meat count was met on both grounds in Area 3 throughout our sampling periods, with the exception of the May fishing on Lurcher where the mean count was 46/500 g.

The distributions of the meat weights for the Brier Island and Lurcher Shoal subareas are shown in figures 10 and 11 respectively, for 1996 and 1997. The pattern for the Brier Island subarea is similar to that of 1996 (despite the change in the meat count from 50 to 45). The one exception was a sample of large meats taken in September in the Brier Island subarea. The meats show a substantial increase in meat weight at this time of year due to changes associated with the reproductive cycle (Kenchington *et al.* 1994). The pattern on Lurcher Shoal (Fig. 11) is similar with the majority of the catch being approximately 10 g (50 straight count) with large meats landed to lower the count. With a strong 1995 year class reaching capture size in 1998 precautions (lower meat count, closures) will have to be taken to prevent growth overfishing.

The fishing locations where the port samples were collected from is shown in figure 12.

Area 3 (Brier Island/Lurcher Shoal) Meat Weight Statistics for the Full Bay Licence Holders by Month and Year Calculated from Port Samples of the Commercial Catch

Year	Month	Meat weight (g)				Sample size	Meat count
		Mean	Min	Max	s.d.	(n meats)	per 500 g
Brier Island Fishing Grounds							
1983	May	10.62	3.66	17.95	3.20	85	47.1
	June	9.00	3.96	27.17	4.19	106	55.6
1991	May	13.55	6.59	38.84	5.70	74	36.9
	June	20.23	4.45	37.55	6.93	50	24.7
1992	June	12.91	5.60	26.20	4.03	77	38.7
	July	13.36	2.80	59.20	8.86	434	37.4
	Sept.	8.64	3.80	17.00	2.12	583	57.9
1993	April	12.50	3.30	25.60	4.74	318	40.0
	May	10.59	3.40	29.60	5.99	280	47.2
	June	9.98	3.90	26.70	3.58	200	50.1
	Sept.	11.31	3.60	42.90	6.51	379	44.2
	Nov.	14.00	7.30	23.70	3.37	71	35.7
1994	March	20.91	9.30	37.00	6.75	53	23.9
	April	19.00	4.90	42.00	7.64	419	26.3
	May	13.64	5.50	22.00	3.20	292	36.7
	June	16.18	4.60	51.50	7.26	1055	30.9
	July	22.00	11.00	37.50	6.30	111	22.7
1996	May	10.80	2.90	25.90	4.33	155	46.3
	July	19.80	15.80	23.90	2.17	35	25.3
	August	15.48	11.10	24.10	3.19	37	32.3
1997	May	13.46	6.30	24.40	4.05	120	37.1
	June	12.46	3.20	38.80	4.79	652	40.1
	July	15.05	5.10	41.70	5.47	1102	33.2
	August	13.96	4.40	45.10	7.64	266	35.8
	Sept.	35.27	21.90	49.00	7.94	36	14.2
	October	17.58	8.20	32.40	6.51	53	28.4

Area 3 (Brier Island/Lurcher Shoal) Meat Weight Statistics for the Full Bay Licence Holders by Month and Year Calculated from Port Samples of the Commercial Catch *cont'd*

Year	Month	Meat weight (g)				Sample size	Meat count
		Mean	Min	Max	s.d.	(n meats)	per 500 g
Lurcher Shoal Fishing Grounds							
1991	June	6.67	2.19	27.58	1.95	1210	75.0
	July	9.17	3.08	33.67	5.15	437	54.5
	August	7.73	3.70	25.51	3.09	134	64.7
1992	June	9.84	3.30	29.00	3.86	312	50.8
	July	10.88	2.50	38.40	4.59	907	46.0
	August	15.20	9.40	27.00	2.75	66	32.9
	Sept.	9.17	4.60	15.70	2.14	446	54.5
1993	April	8.89	3.00	23.80	3.79	225	56.2
	May	7.00	3.00	25.30	2.44	711	71.4
	June	8.21	3.10	17.00	2.02	122	60.9
	Sept.	10.04	3.50	27.80	3.96	597	49.8
	Nov.	14.06	6.10	30.40	4.77	142	35.6
1994	April	15.72	5.60	43.50	7.10	380	31.8
	May	14.40	3.60	32.30	3.80	851	34.7
	July	12.31	4.80	34.30	4.05	971	40.6
1995	June	16.64	5.50	26.70	4.69	59	30.0
	July	14.33	5.70	29.30	4.61	344	34.9
	August	14.16	5.80	24.80	4.37	78	35.3
1996	June	11.83	4.30	29.20	4.01	350	42.3
	July	13.30	4.00	37.10	5.89	279	37.6
	August	17.58	10.40	25.30	3.34	75	28.4
	Nov.	12.40	5.10	28.00	4.30	243	40.3
1997	May	10.87	3.20	33.70	4.01	951	46.0
	June	13.11	3.50	40.90	5.74	874	38.1
	July	12.96	3.70	38.40	5.08	1015	38.6
	August	13.08	4.00	38.40	6.30	232	38.2
	Sept.	11.58	3.30	33.50	4.99	217	43.2
	October	14.79	5.10	32.40	5.44	125	33.8

Conclusions and Management Considerations

The 1997 stock survey showed little change in the average number of scallops per standard tow in the recruited age classes (4+), but an increase in the total average number due to the presence of a strong 1995 year class. This year class is distributed in the shallow water areas throughout Area 3. An important consideration in the 1998 fishery will be to protect the 1995 year class from growth overfishing. The wide distribution of the animals is not amenable to a partial closure of the area, and as three year olds, this year class will be captured by the gear in 1998. In order to permit fishing while protecting this year class, a reduction in the meat count below that recommended for yield optimization has been proposed. The 1998 management plan calls for a reduced meat count in this Area from 45 meats/500 g to 40 meats/500 g (blended counts). The scallops in the Brier Island portion of Area 3 reach a straight meat count of 40 at age 7, while this weight is not achieved (on average) until age 9 in the Lurcher portion of Area 3.

Area 3. Straight Meat Count-at-Age (Number/500g)

Age	**2**	**3**	**4**	**5**	**6**
Brier	515	179	87	61	49
Lurcher	472	173	108	75	60
Age	**7**	**8**	**9**	**10**	
Brier	42	37	34	26	
Lurcher	52	47	42	32	

The recommended meat count for Area 3 is a straight 45/500g based on generalized models of yield and growth for this Area (Kenchington *et al.* 1997). The reduction in the meat count to a straight 40/500g would have very little impact on the proportion of the stock available to the fishery on the Brier Island beds, but will reduce the proportion of the available catch by approximately 7% on the Lurcher grounds. The scallops on these grounds are known to reproduce and so contribute to the spawning stock in the Area. Straight counts would protect the 1995 year class if set at either the 45 or 40 count level. The proposed meat count of 40 in the management plan is a blended count and so it will not necessarily protect the smaller scallops, however, it will be more restrictive on the smaller scallops than a 45 blended count. In other words, it may force some targeting of larger animals within the proportion available to the fleet. It is impossible to model the effects of blended counts with so much variation in meat weight at age/size on the grounds, and so many year classes present. Various scenarios of straight meat count (Ct. = Number/500 g) and the proportion of the available stock by weight above the count are displayed below:

	Brier Island			**Lurcher Shoal**		
Ct.	1995	1996	1997	1995	1996	1997
50	0.75	0.80	0.63	0.45	0.45	0.35
45	0.61	0.63	0.56	0.36	0.34	0.25
40	0.61	0.63	0.56	0.27	0.24	0.18
30	0.39	0.32	0.22	0.21	0.18	0.14

Landings are similar to those reported in 1996 although CPUE was lower, and effort was higher. Exploitation rate on recruited scallops calculated from the surveys decreased dramatically from 1996 to 1997 to approximately 20% from 45% in 1995 to 1996, especially on the Lurcher grounds. This is a positive change and indicates that the 1997 harvest cap was effective in reducing exploitation. Commercial port sampling does not show any change resulting from the decrease in the meat count from a blended 50/500 g to 45/500 g from 1996 to 1997. The fishery in this area continues to capture more smaller meats (approximately 10 g) than larger ones.

References

Black, G.A.P., 1988. ACON- A shaded contour program for plotting irregularly spaced data. Unpublished manuscript, Department of Fisheries and Oceans, Scotia-Fundy Region. Version 4.18, 50pp.

Kenchington, E., Lundy, M.J. and V. Hazleton, 1994. Seasonal changes in somatic and reproductive tissue weights in wild populations of *Placopecten magellanicus* from the Bay of Fundy, Canada. In: Bourne, N.F.,Bunting, B.L. and Townsend, L.D., eds. Proceedings of the 9th International Pectinid Workshop, Nanaimo, B.C., Canada, April 22-27, 1993. Volume 2. *Can Tech. Rep. Fish. Aquat. Sci.*, pp. 154-162.

Kenchington, E. and M.J. Lundy, 1996. 1995 Bay of Fundy Scallop Stock Assessments: Brier Island and Lurcher Shoal. *DFO Atl. Fish. Res. Doc.* 96/15: 31 pp.

Kenchington, E., Lundy, M.J. and S.J. Smith, 1997. Bay of Fundy scallop stock assessment: Areas 2, 3, 4, 5, 7. *Can. Stock Assess. Secretariat Res. Doc.* 97/63, 98 pp.

Merrill, A.S. and J.A. Posgay, 1964. Estimating the natural mortality rate of the sea scallop (*Placopecten magellanicus*). *ICNAF Research Bulletin* 1: 88-106.

Robert, G. and M.J. Lundy, 1989. Gear performance in the Bay of Fundy scallop fishery II.- Selectivity studies. *Can. Atl. Fish. Sci. Adv. Comm. Res. Doc.* 89/17, 32 pp.

Robert, G., Butler-Connolly, M.A.E and M.J. Lundy, 1990. Bay of Fundy scallop stock assessment-1989. *Can. Atl. Fish. Sci. Adv. Comm. Res. Doc.* 90/31, 35pp.

Watson, D.F. and G.P. Phillip, 1985. A refinement of inverse distance weighted interpolation. *Geo-Processing* 2: 315-327.

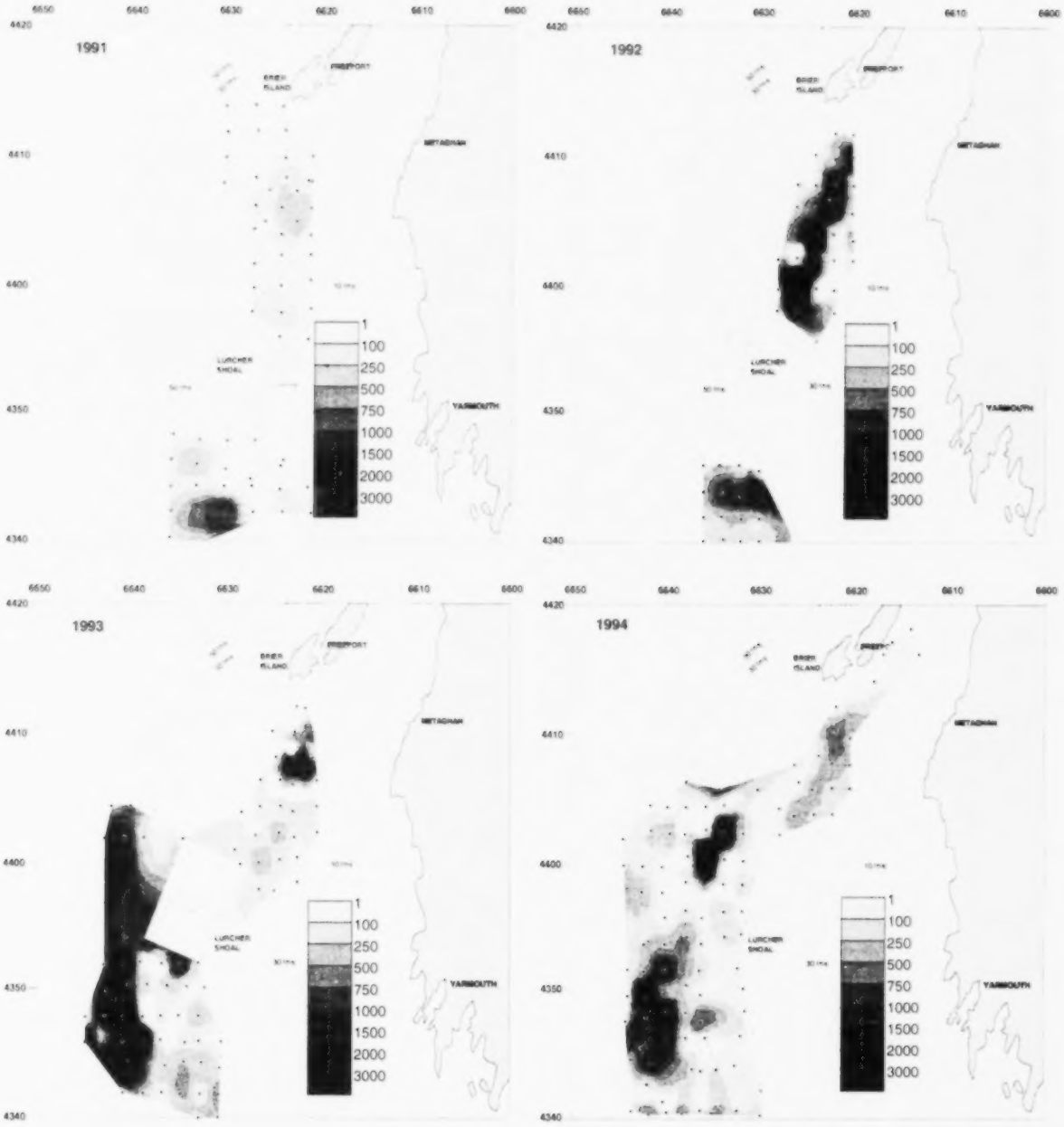


Figure 1. Scallop abundance (1991-1997) on the fishing grounds below Brier Island, N.S. (Area 3) as calculated from annual research surveys. Spatial distribution by age has been recalculated with updated growth parameters. Darkening shades of grey refer to increasing number of scallops per standard tow (grey scale in lower corner of plot). The scales are the same on all maps to facilitate comparison between years.

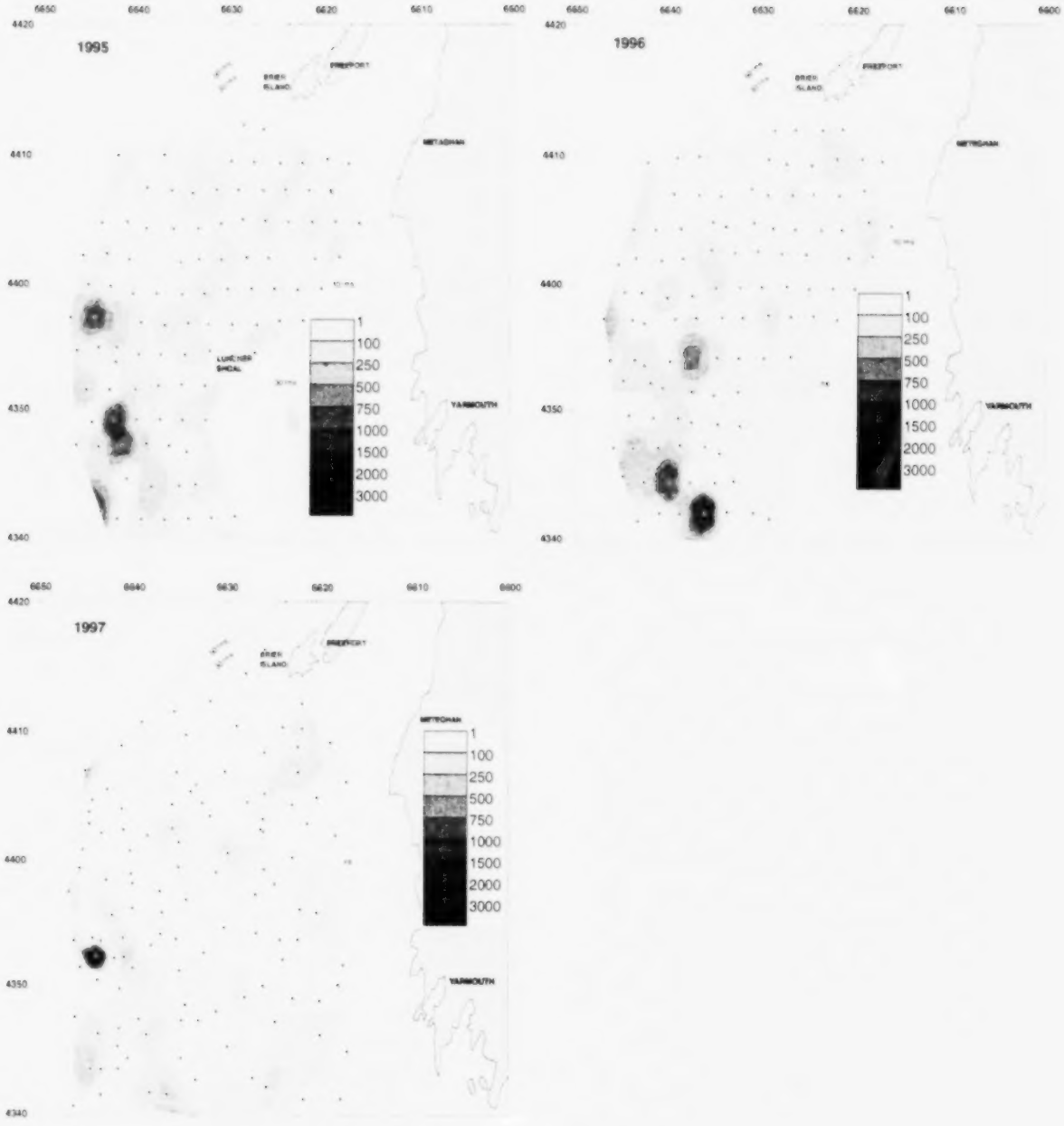


Figure 1 cont'd. Scallop abundance (1991-1997) on the fishing grounds below Brier Island, N.S. (Area 3) as calculated from annual research surveys. Spatial distribution by age has been recalculated with updated growth parameters. Darkening shades of grey refer to increasing number of scallops per standard tow (grey scale in lower corner of plot). The scales are the same on all maps to facilitate comparison between years.

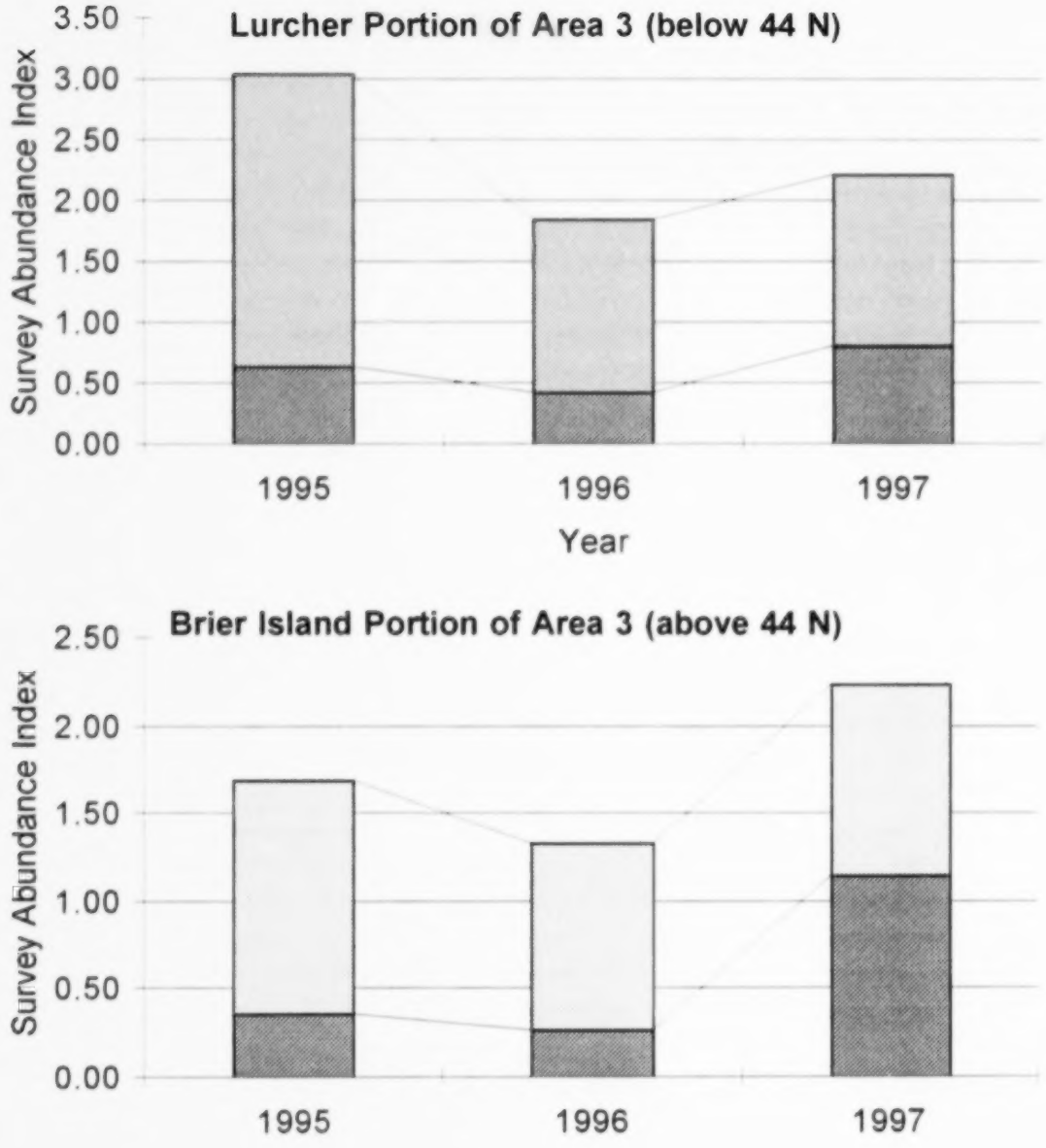


Figure 2. Survey abundance indices for the Lurcher Shoal and Brier Island subareas of Scallop Production Area 3. The number of prerecruits (< 4 years old) are in the darker shading and the number of recruits (> 3 years old) in the lighter shading.

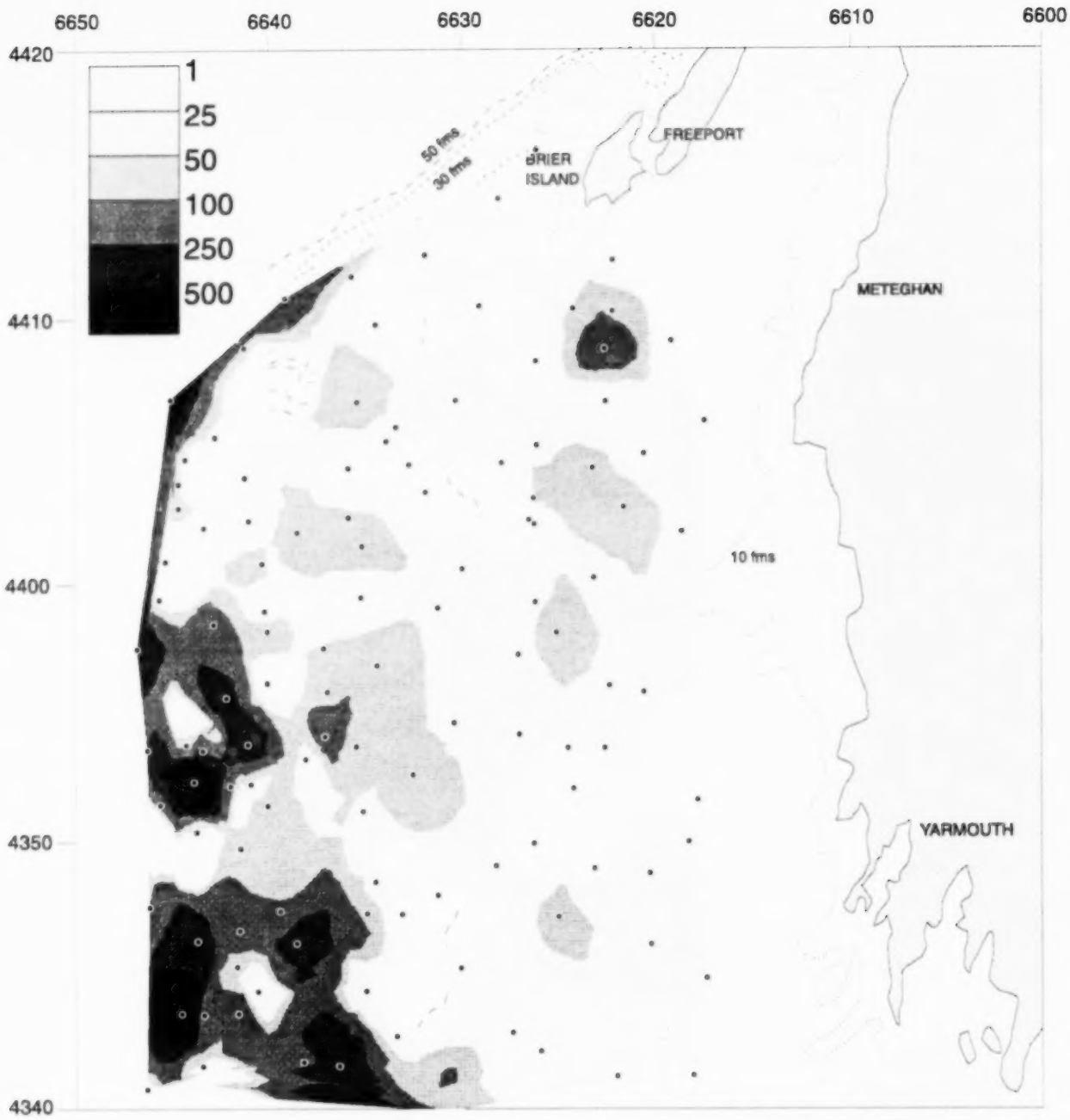


Figure 3. Spatial distribution of scallops > 80 mm shell height in Area 3 determined from abundance data collected during the 1997 research vessel survey. Darkening shades of grey within isopleths refer to increasing number of scallops per standard tow (grey scale in upper corner of map). Tow locations are depicted as dots.

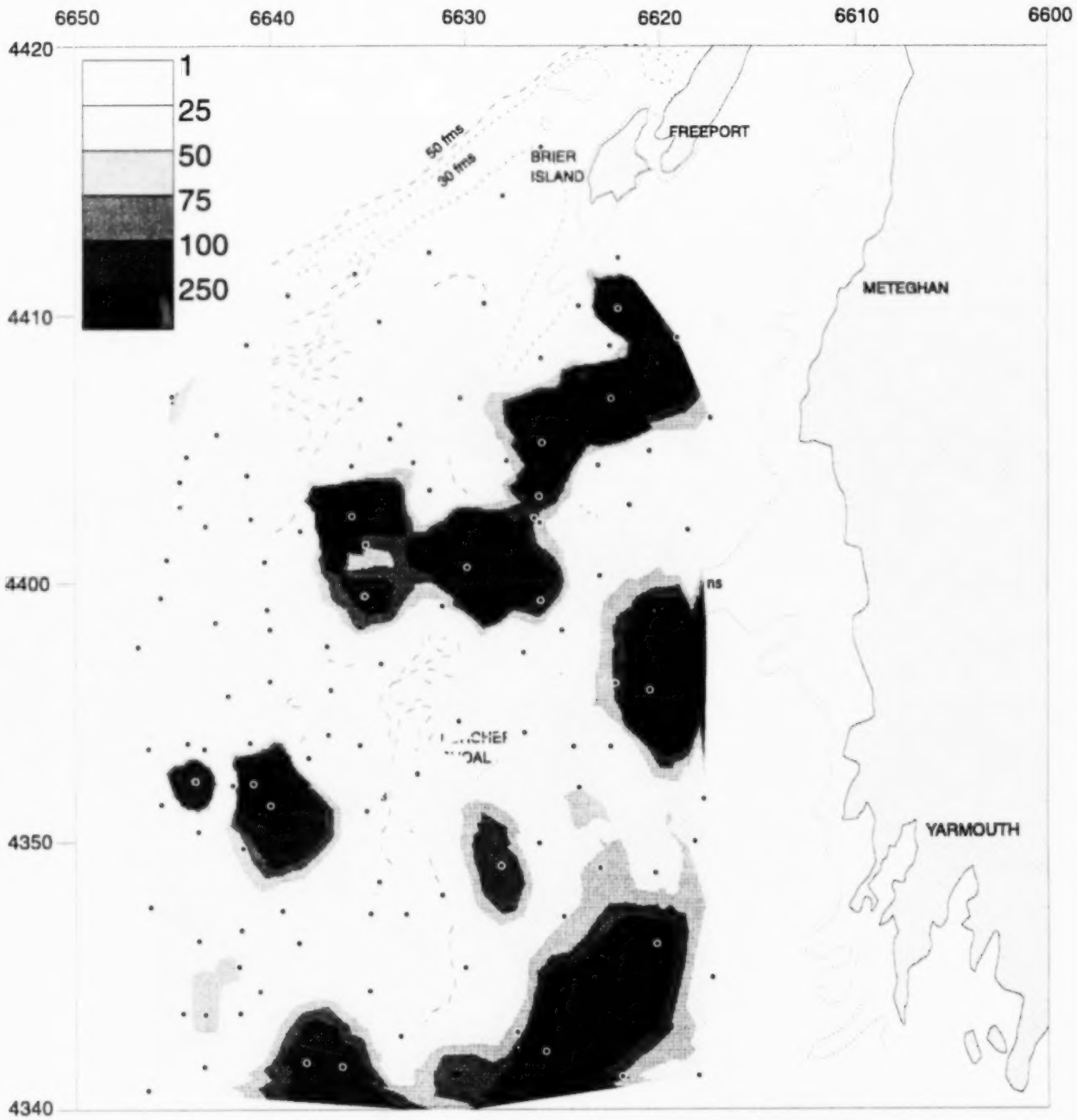


Figure 4. Spatial distribution of scallops < 80 mm shell height in Area 3 determined from abundance data collected during the 1997 research vessel survey. Darkening shades of grey within isopleths refer to increasing number of scallops per standard tow (grey scale in upper corner of map). Tow locations are depicted as dots.

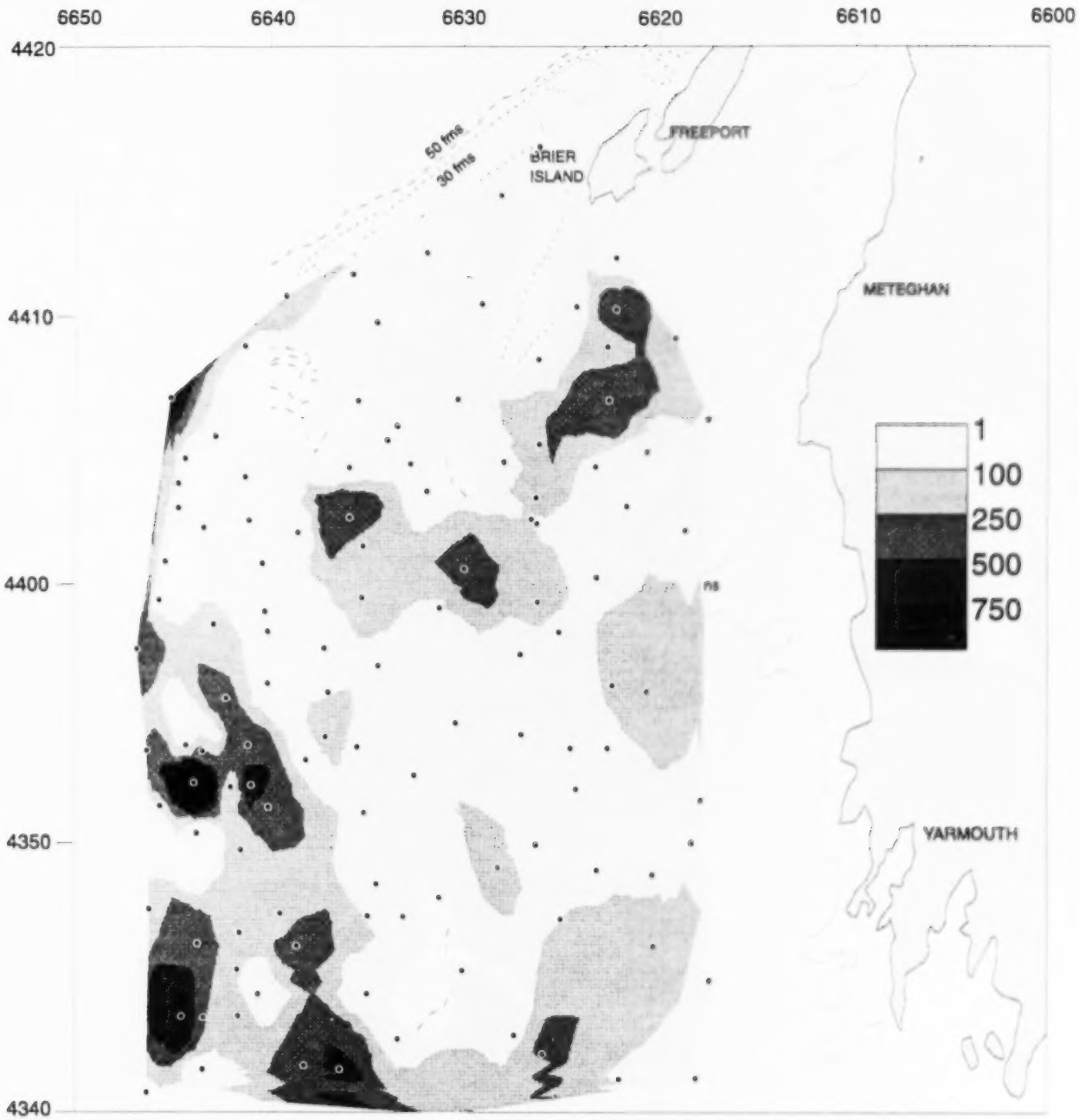


Figure 5. Spatial distribution of the total number of scallops in Area 3 determined from abundance data collected during the 1997 research vessel survey. Darkening shades of grey within isopleths refer to increasing number of scallops per standard tow (grey scale in upper corner of map). Tow locations are depicted as dots.

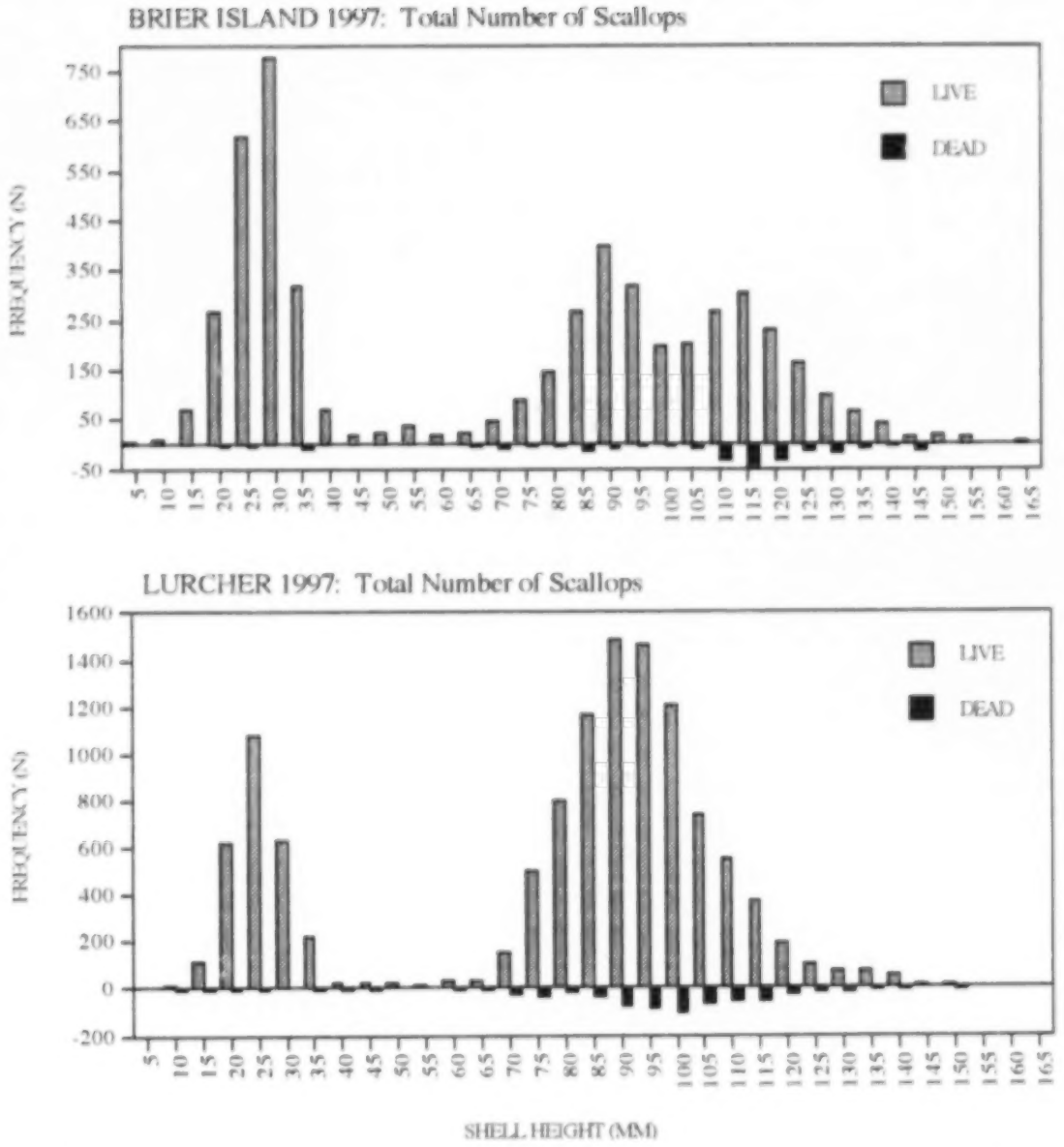


Figure 6. Shell height frequency distribution by subarea of the prorated total number of scallops caught during the 1997 stock survey of Area 3. Forty-seven tows were made in the Brier Island subarea and 73 tows were made in the Lurcher subarea. The number of live animals is shown above the 0 frequency line. The number of dead animals (clappers) is shown below the 0 frequency line.

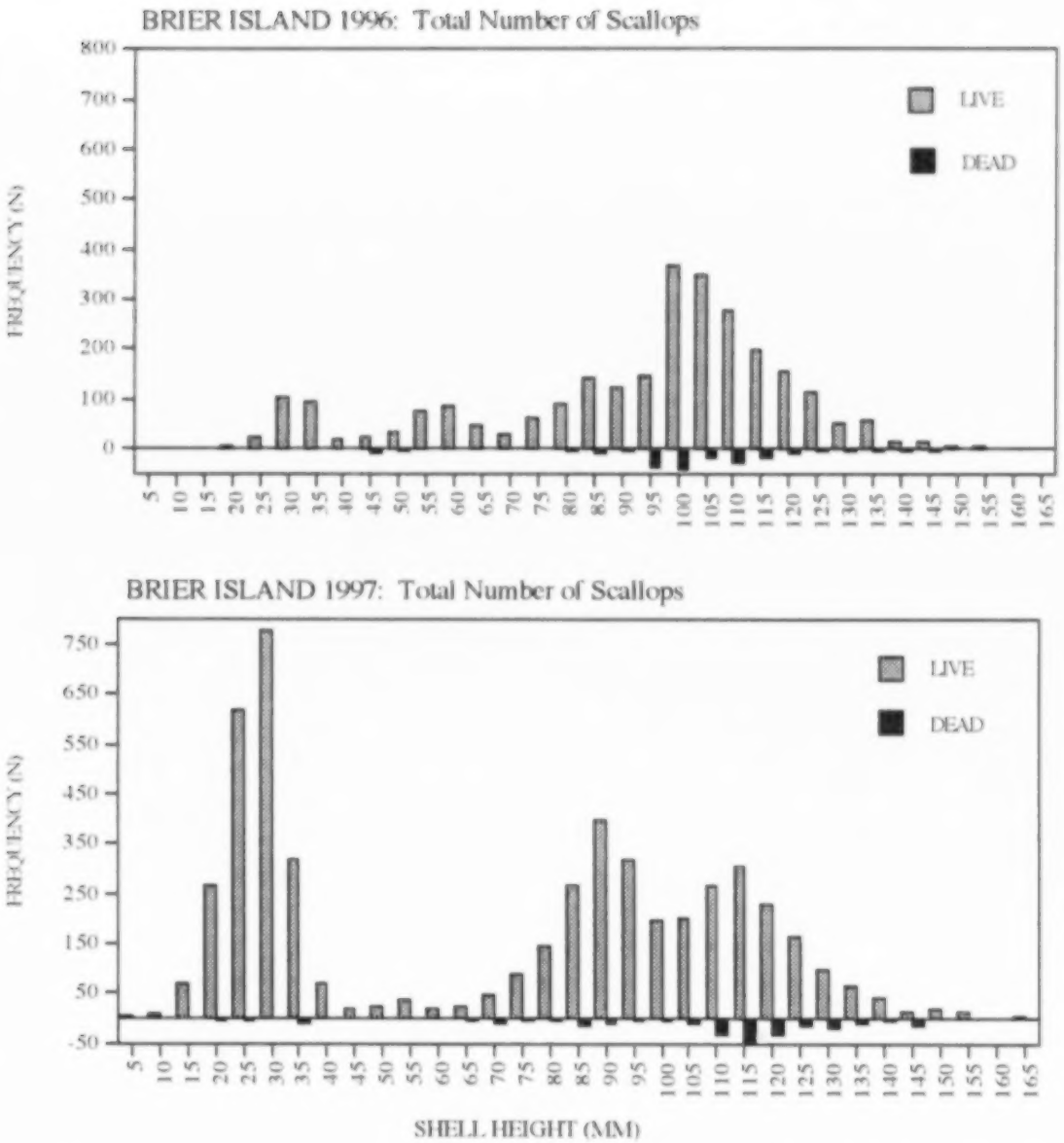


Figure 7. Shell height frequency distribution of the prorated total number of scallops caught during the 1997 stock survey of the Brier Island subarea (north of 44°N) of Area 3. In 1997, 47 tows were made in the Brier Island subarea and 45 tows were made in 1996. The number of live animals is shown above the 0 frequency line. The number of dead animals (clappers) is shown below the 0 frequency line.

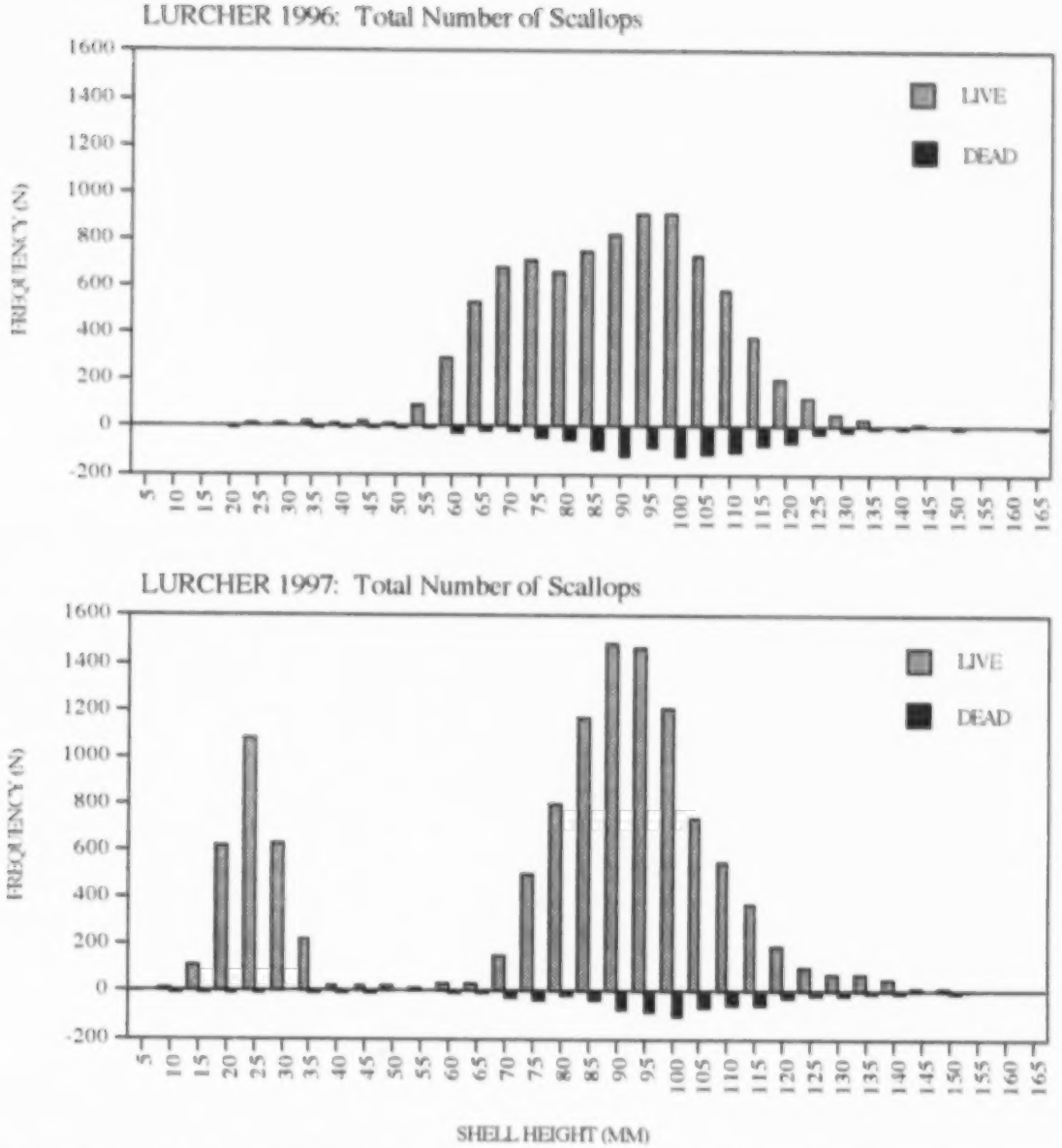


Figure 8. Shell height frequency distribution of the prorated total number of scallops caught during the 1997 stock survey of the Lurcher subarea (south of 44°N) of Area 3. In 1997, 73 tows were made in this subarea, and in 1996, 68 tows were completed. The number of live animals is shown above the 0 frequency line. The number of dead animals (clappers) is shown below the 0 frequency line.

F igure 9. Fishing locations in Area 3 according to logbook data.

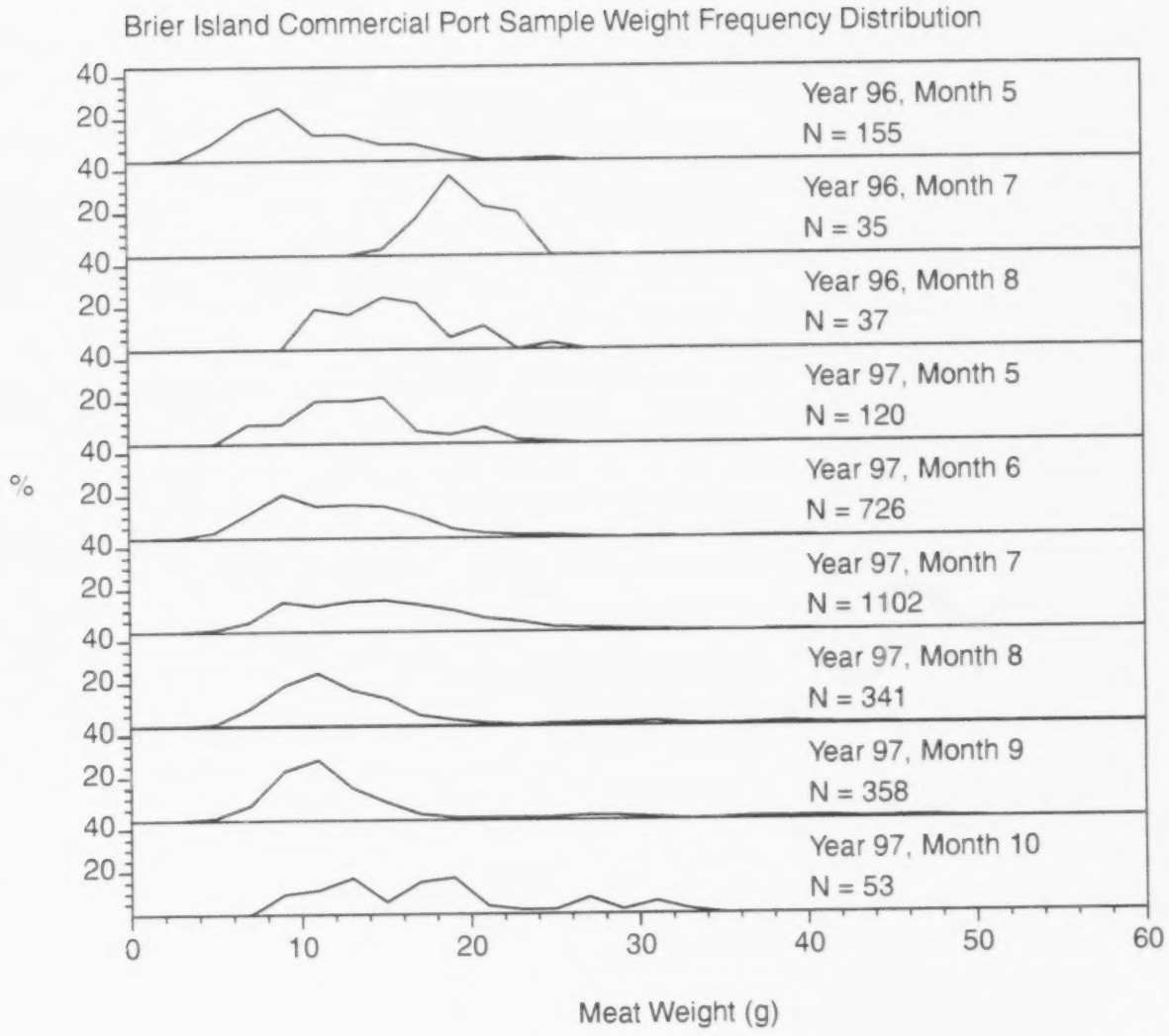


Figure 10. Meat weight frequency distribtuion of the commercial port samples collected in 1996 and 1997 from the Brier Island portion of Area 3.

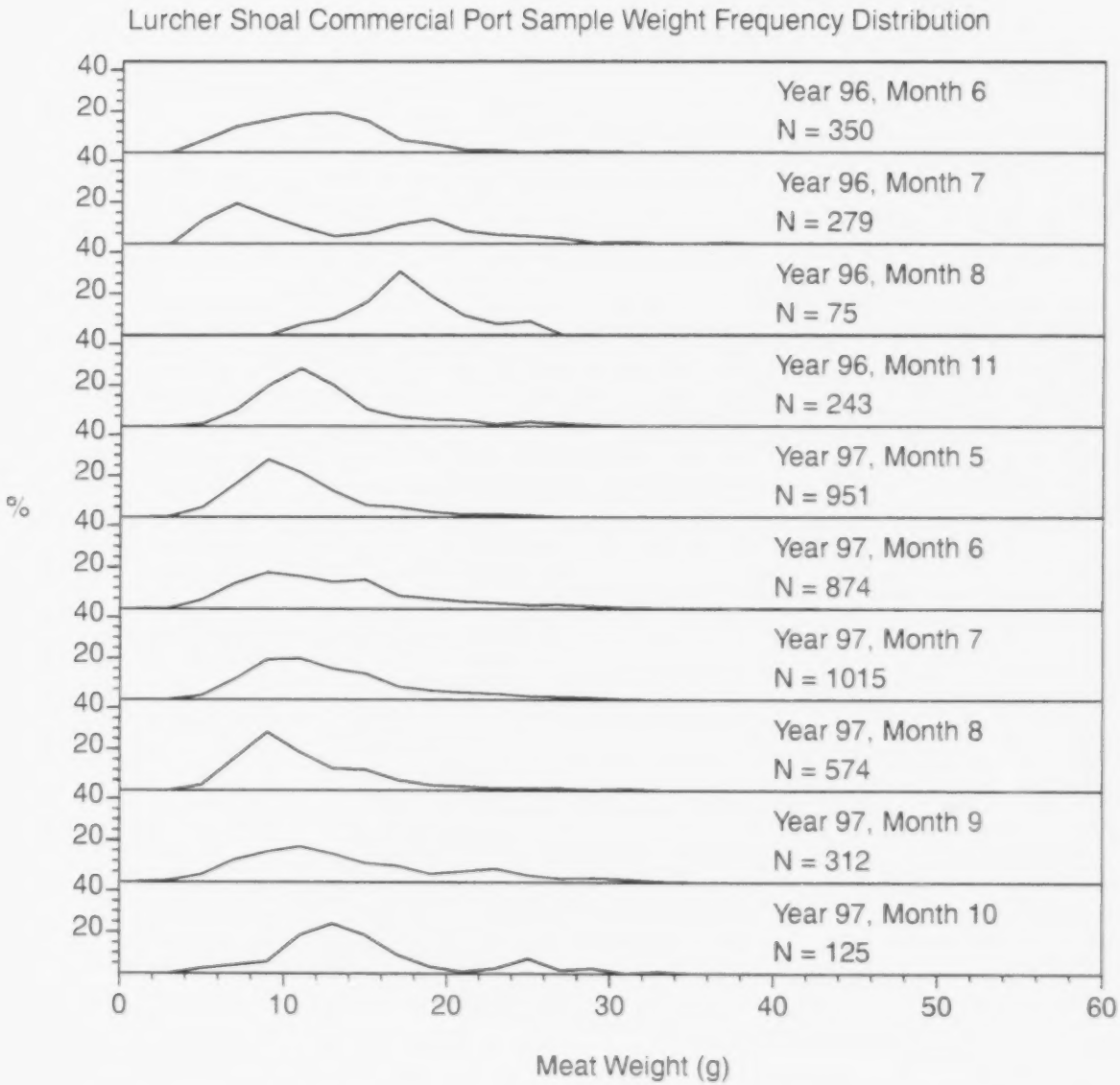


Figure 11. Meat weight frequency distribtuion of the commercial port samples collected in 1996 and 1997 from the Lurcher Shoal portion of Area 3.

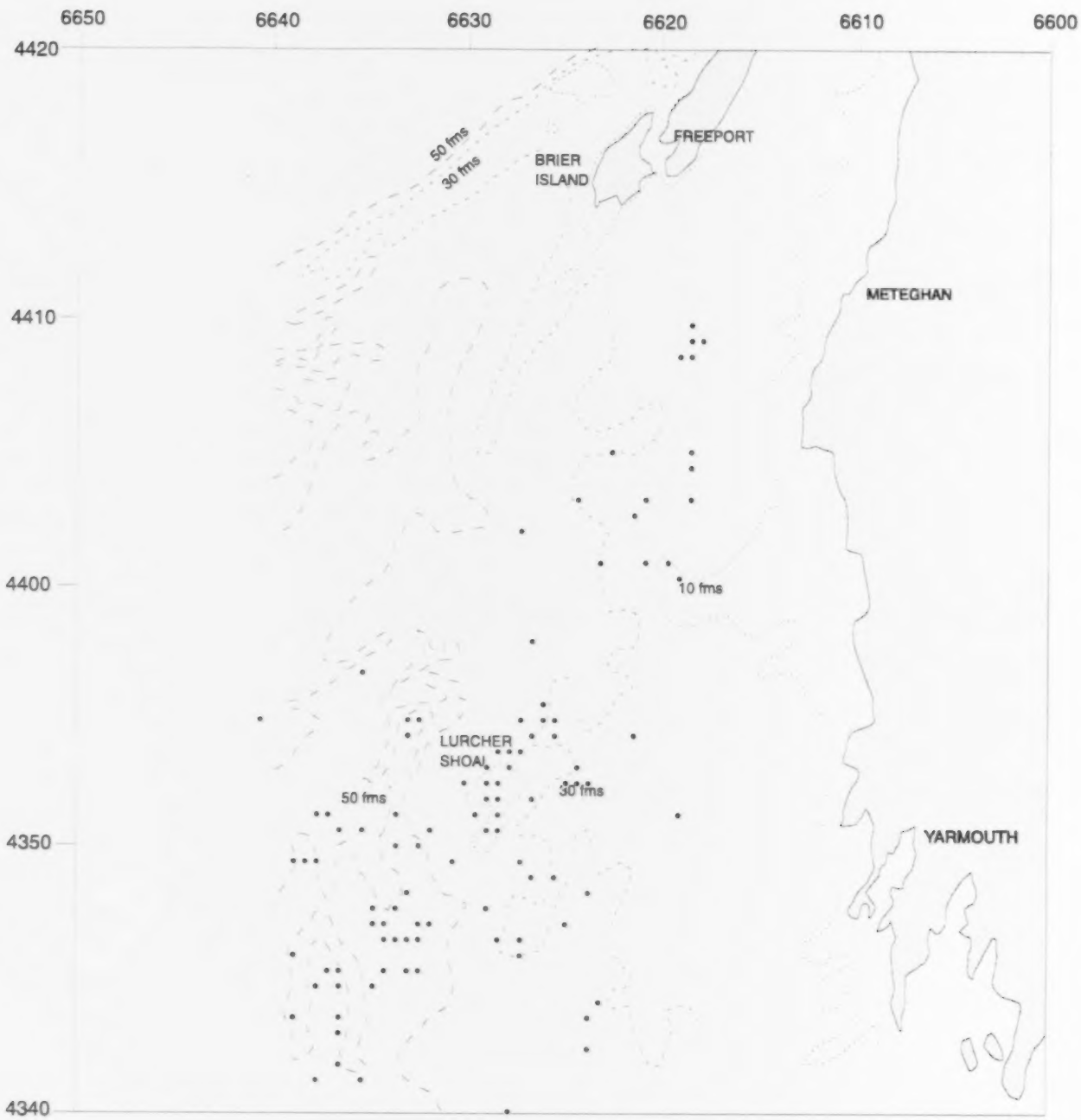


Figure 12. Locations where the port samples were collected from in Area 3.